Section 1

The Characteristics of Seed Plants

Objectives

After this lesson, students will be able to

A.5.1.1 Identify the characteristics that seed plants share.

A.5.1.2 Explain how seeds become new plants.

A.5.1.3 Describe the functions of roots, stems, and leaves.

Target Reading Skill

Outlining Explain that using an outline format helps students organize information by main topic, subtopic, and details.

Answer

The Characteristics of Seed Plants

I. What Is a Seed Plant?
  A. Vascular Tissue
  B. Seeds

II. How Seeds Become New Plants
  A. Seed Structure
  B. Seed Dispersal
  C. Germination

III. Roots
  A. Types of Roots
  B. The Structure of a Root

IV. Stems
  A. The Structure of a Stem
  B. Annual Rings

V. Leaves
  A. The Structure of a Leaf
  B. The Leaf and Photosynthesis
  C. Controlling Water Loss

All in One Teaching Resources

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Preteach

Build Background Knowledge

L2

Plants With and Without Seeds

Have students generate a list of plants they see everyday. Have them write the name of each plant under one of the following headings: *Has Seeds* or *Does Not Have Seeds*. Tell students that not only are most of the plants they are familiar with seed plants but that seed plants make up the greater number of all plants.

Section 1

The Characteristics of Seed Plants

Reading Preview

Key Concepts

- What three characteristics do seed plants share?
- How do seeds become new plants?
- What are the main functions of roots, stems, and leaves?

Key Terms

- phloem • xylem • pollen
- seed • embryo • cotyledon
- germination • root cap
- cambium • stomata
- transpiration

Target Reading Skill

Outlining As you read, make an outline about seed plants that you can use for review. Use the red headings for the main ideas and the blue headings for the supporting ideas.

The Characteristics of Seed Plants
I. What is a seed plant?
A. Vascular tissue
B.
II. How seeds become new plants
A.
B.

Lab zone Discover Activity

Which Plant Part Is It?

1. With a partner, carefully observe the items of food your teacher gives you.
2. Make a list of the food items.
3. For each food item, write the name of the plant part—root, stem, or leaf—from which you think it is obtained.

Think It Over

Classifying Classify the items into groups depending on the plant part from which the food is obtained. Compare your groupings with those of your classmates.

Have you ever planted seeds in a garden? If so, then you may remember how it seemed to take forever before those first green shoots emerged. Shortly afterwards, you saw one set of leaves, and then others. Then a flower may have appeared. Did you wonder where all those plant parts came from? How did they develop from one small seed? Read on to find out.

What Is a Seed Plant?

The plant growing in your garden was a seed plant. So are most of the other plants around you. In fact, seed plants outnumber seedless plants by more than ten to one. You eat many seed plants—rice, peas, and squash, for example. You wear clothes made from seed plants, such as cotton and flax. You may live in a home built from seed plants—oak, pine, or maple trees. In addition, seed plants produce much of the oxygen you breathe.

Seed plants share two important characteristics. They have vascular tissue, and they use pollen and seeds to reproduce. In addition, all seed plants have body plans that include roots, stems, and leaves. Like seedless plants, seed plants have complex life cycles that include the sporophyte and the gametophyte stages. In seed plants, the plants that you see are the sporophytes. The gametophytes are microscopic.

Lab zone Discover Activity

Skills Focus Classifying L1

Materials edible parts of seed plants such as carrots, parsnips, broccoli, cabbage, lettuce, celery, parsley, potato, onion (do not use fruits, the mature ovary of flowers)

Time 10 minutes

Tips Mention that underground plant parts are not necessarily roots. For example, potatoes and onions are underground stems. Celery is not a true stem, but a leaf stalk.

Expected Outcome Carrots and parsnips are roots, lettuce and cabbage are leaves, and broccoli is a stem.

Think It Over The foods should be classified as roots, stems, or leaves.

FIGURE 1
Harvesting Wild Rice
Like all seed plants, wild rice plants have vascular tissue and use seeds to reproduce. The seeds develop in shallow bodies of water, and the plants grow up above the water's surface. These men are harvesting the mature rice grains.

Vascular Tissue Most seed plants live on land. Recall from Chapter 4 that land plants face many challenges, including standing upright and supplying all their cells with food and water. Like ferns, seed plants meet these two challenges with vascular tissue. The thick walls of the cells in the vascular tissue help support the plants. In addition, food, water, and nutrients are transported throughout the plants in vascular tissue.

There are two types of vascular tissue. **Phloem** (FLOH um) is the vascular tissue through which food moves. When food is made in the leaves, it enters the phloem and travels to other parts of the plant. Water and minerals, on the other hand, travel in the vascular tissue called **xylem** (ZY lum). The roots absorb water and minerals from the soil. These materials enter the root's xylem and move upward into the stems and leaves.

Pollen and Seeds Unlike seedless plants, seed plants can live in a wide variety of environments. Recall that seedless plants need water in their surroundings for fertilization to occur. Seed plants do not need water for sperm to swim to the eggs. Instead, seed plants produce **pollen,** tiny structures that contain the cells that will later become sperm cells. Pollen delivers sperm cells directly near the eggs. After sperm cells fertilize the eggs, seeds develop. A **seed** is a structure that contains a young plant inside a protective covering. Seeds protect the young plant from drying out.

Reading Checkpoint **What material travels in phloem? What materials travel in xylem?**

Differentiated Instruction

English Learners/Beginning L1
Vocabulary: Science Glossary Pair students with English proficient students. Have them work together to create a glossary that includes the phonetic English pronunciation and the definition for each key term. Students can draw and label their own diagrams of the structures. **learning modality: verbal**

English Learners/Intermediate L1
Vocabulary: Science Glossary Have students do the *Beginning* activity, then write a sentence that uses each of these words. Call on students to read their sentences aloud to give them an opportunity to practice pronunciation. **learning modality: verbal**

Instruct

What Is a Seed Plant?

Teach Key Concepts L2

Characteristics of Seed Plants

Focus Remind students that ferns have vascular tissue and reproduce using spores.

Teach Ask: **What two characteristics are common to all seed plants?** *(Vascular tissue and seeds to reproduce)* **Which is different from ferns?** *(Ferns reproduce using spores.)* **What is the body structure of seed plants?** *(Plant bodies include roots, stems, and leaves.)*

Apply Remind students that seed plants evolved after mosses and ferns. Ask: **How did the evolution of seeds allow plants to live in places where mosses and ferns could not?** *(Seeds provide protection for the young plant inside. With seeds, plants can reproduce in drier environments.)* **learning modality: verbal**

Independent Practice L2

All in One Teaching Resources

- Guided Reading and Study Worksheet: *The Characteristics of Seed Plants*

Student Edition on Audio CD

Monitor Progress L2

Drawing Have students make flowcharts showing the movement of food, water, and nutrients through a vascular plant. *(Phloem—food moves from leaves to stems, roots, and other parts; xylem—water and minerals travel from roots into stems and leaves.)* Students can save their flowcharts in their portfolios. Portfolio

Answer

Reading Checkpoint Food travels in phloem. Water and minerals travel in xylem.

How Seeds Become New Plants

Teach Key Concepts L2

What's Inside a Seed?

Focus Remind students that unlike seedless plants, seeds do not need water to be capable of surviving.

Teach Explain that one of the main parts of a seed is the seed coat, which keeps the seed from drying out. Ask: **What else is inside a seed?** *(A partially developed plant, or embryo)* **Why does the seed contain stored food?** *(The embryo uses the stored food until it can make its own food.)* **What is germination?** *(The early growth stage of the embryo)* Refer students to Figure 4 and ask them to describe the process of germination. *(The embryo uses its food, the roots grow downward, and the stem and leaves begin to grow upward.)*

Apply Ask: **Why is it an advantage for seeds to be able to remain inactive and not germinate immediately after the embryo forms?** *(This allows for them to be dispersed and to germinate under ideal growing conditions.)* **learning modality: verbal**

Use Visuals: Figure 2 L2

Seed Structure

Focus Have students locate the main parts in each seed.

Teach Ask: **What structures are common to all the seeds?** *(Seed coat, embryo, stored food, cotyledon)* **What plant characteristics can you see in the embryos?** *(The beginnings of roots, stems, and leaves)*

Apply Tell students to note the areas of stored food. Explain that when seeds absorb water, the food-storing tissues swell, which cracks open the seed coat. **learning modality: visual**

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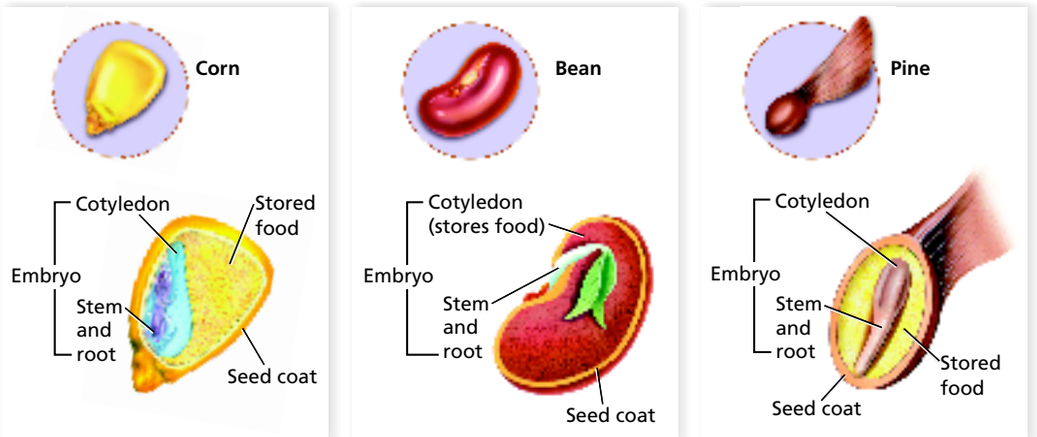
FIGURE 2

Seed Structure

The structures of three different seeds are shown here.

Inferring *How is the stored food used?*



Lab zone **Try This Activity**

The In-Seed Story

1. Your teacher will give you a hand lens and two different seeds that have been soaked in water.
2. Carefully observe the outside of each seed. Draw what you see.
3. Gently remove the coverings of the seeds. Then carefully separate the parts of each seed. Use a hand lens to examine the inside of each seed. Draw what you see.

Observing Based on your observations, label the parts of each seed. Then describe the function of each part next to its label.

How Seeds Become New Plants

All seeds share important similarities. **Inside a seed is a partially developed plant. If a seed lands in an area where conditions are favorable, the plant sprouts out of the seed and begins to grow.**

Seed Structure A seed has three main parts—an embryo, stored food, and a seed coat. The young plant that develops from the zygote, or fertilized egg, is called the **embryo.** The embryo already has the beginnings of roots, stems, and leaves. In the seeds of most plants, the embryo stops growing when it is quite small. When the embryo begins to grow again, it uses the food stored in the seed until it can make its own food by photosynthesis. In all seeds, the embryo has one or more seed leaves, or **cotyledons** (kaht uh LEED unz). In some seeds, food is stored in the cotyledons. In others, food is stored outside the embryo. Figure 2 compares the structure of corn, bean, and pine seeds.

The outer covering of a seed is called the seed coat. Some familiar seed coats are the "skins" on lima beans and peanuts. The seed coat acts like plastic wrap, protecting the embryo and its food from drying out. This allows a seed to remain inactive for a long time. In many plants, the seeds are surrounded by a structure called a fruit, which you will learn more about in Section 3.

Lab zone **Try This Activity**

Skills Focus Observing L2

Materials hand lens; dried kidney, lima, or black beans; dried yellow or green peas; shelled peanuts

CAUTION: *Some students have severe reactions to eating peanuts or inhaling peanut dust. Do not use peanuts if any student is allergic to them.*

Time 10 minutes

Tips Before the activity, soak the beans for 2 hours and the peas for 24 hours. Remove peanuts from their shells 3 or 4 days before the activity, and store them in a moist place so the cotyledons will open.

Expected Outcome Students will observe that each of the seeds is composed of two sections that can easily be separated. They will see the tiny leaves and root (and possibly the miniature stem) of the embryo plant. Sketches should include the seed coat, the cotyledons, and the embryo.

Extend Invite students to repeat the activity with other kinds of seeds. **learning modality: kinesthetic**

Seed Dispersal After seeds have formed, they are usually scattered, sometimes far from where they were produced. The scattering of seeds is called seed dispersal. Seeds are dispersed in many ways. One method involves other organisms. For example, some animals eat fruits, such as cherries or grapes. The seeds inside the fruits pass through the animal's digestive system and are deposited in new areas. Other seeds are enclosed in barblike structures that hook onto an animal's fur or a person's clothes. The structures then fall off the fur or clothes in a new area.

A second means of dispersal is water. Water can disperse seeds that fall into oceans and rivers. A third dispersal method involves wind. Wind disperses lightweight seeds that often have structures to catch the wind, such as those of dandelions and maple trees. Finally, some plants eject their seeds in a way that might remind you of popping popcorn. The force scatters the seeds in many directions.

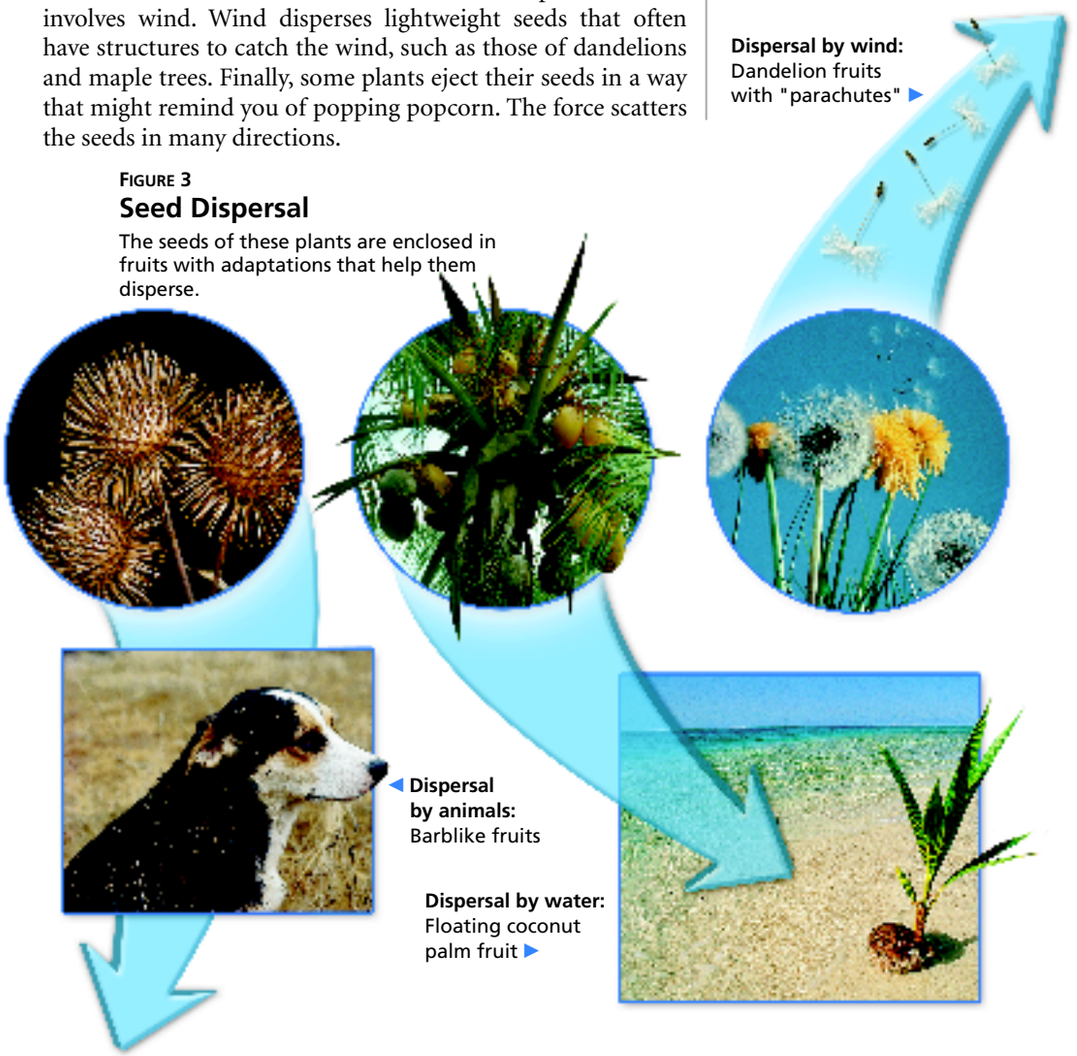


FIGURE 3
Seed Dispersal
The seeds of these plants are enclosed in fruits with adaptations that help them disperse.

Differentiated Instruction

Less Proficient Readers L1
Checking for Understanding After students have read the section, have them work in groups of four to write 10 questions about the characteristics of seed plants. Suggest they compose a variety of short-answer, fill in the blank, and matching questions. Remind them to create answer keys as well. Then have groups exchange questions and complete them. Students can check their answers using the answer keys. You may wish to make copies of the questions and answer keys for all students to use as study aids.
learning modality: verbal

Lab zone **Build Inquiry** L2

Modeling Seed Dispersal

Time 25 minutes

Materials tissue paper, modeling clay, plastic foam balls, plastic spoons, table tennis balls, hook-and-loop fastener strips, and other arts and crafts materials

Focus Use Figure 3 to review the different ways that plants disperse seeds.

Teach Explain to students that the structure (fruit) that encloses the seeds helps the seeds disperse. Have students work together to build model seeds that can be dispersed by wind, water, or by sticking to clothes or animal fur. Encourage students to predict how far their seeds will travel and then to test their predictions. Students can present their models to the class, identifying how their model seeds are similar to real seeds and how their models could be improved.

Apply Ask: **What properties or characteristics are most important for each method of dispersal?** *(Possible answers: Animal fur—seed must stick to fur with barbs or similar structures; water—seed must float; wind—seed has structures to catch the wind; mechanical—small, dense, compact)*
learning modality: kinesthetic

Monitor Progress L2

Drawing Have students draw a seed and label the embryo, stored food, and seed coat. Then have students describe each labeled part.

Answer
Figure 2 Seeds store food so the embryo has food until it can make its own.

Seed Plants

Show the Video Field Trip to help students understand seed dispersal and development. Discussion question: **What are some ways in which seeds can be dispersed?** *(By wind, water, animal, or be ejected)*

Roots

Teach Key Concepts L2

Functions of Roots

Focus Point out to students that unlike nonvascular plants, seed plants are vascular plants and they have true roots.

Teach Ask: **What do roots do for a plant?** *(Anchor the plant in soil and absorb water and nutrients)* **What types of roots are there?** *(Some plants have a taproot, a long thick main root reaching down into the soil. Other plants have thin fibrous roots that form a tangled mass and take soil with them when they are pulled.)* **What is the purpose of a root cap?** *(It protects the root from injury.)*

Apply Ask: **Which root type is likely to be more useful in preventing soil erosion?** *(The fibrous root system holds soil between the root fibers so it works better than a tap root in preventing erosion.)* **learning modality: verbal**

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Germination After a seed is dispersed, it may remain inactive for a while before it germinates. **Germination** (jur muh NAY shun) occurs when the embryo begins to grow again and pushes out of the seed. Germination begins when the seed absorbs water from the environment. Then the embryo uses its stored food to begin to grow. As shown in Figure 4, the embryo's roots first grow downward; then its stem and leaves grow upward. Once you can see a plant's leaves, the plant is called a seedling.

A seed that is dispersed far from its parent plant has a better chance of survival. When a seed does not have to compete with its parent for light, water, and nutrients, it has a better chance of becoming a seedling.

Reading Checkpoint **What must happen in order for germination to begin?**

Roots

Have you ever tried to pull a dandelion out of the soil? It's not easy, is it? That is because most roots are good anchors. Roots have three main functions. **Roots anchor a plant in the ground, absorb water and minerals from the soil, and sometimes store food.** The more root area a plant has, the more water and minerals it can absorb.

Types of Roots The two main types of root systems are shown in Figure 5. A fibrous root system consists of many similarly sized roots that form a dense, tangled mass. Plants with fibrous roots take much soil with them when you pull them out of the ground. Lawn grass, corn, and onions have fibrous root systems. In contrast, a taproot system has one long, thick main root. Many smaller roots branch off the main root. A plant with a taproot system is hard to pull out of the ground. Carrots, dandelions, and cacti have taproots.

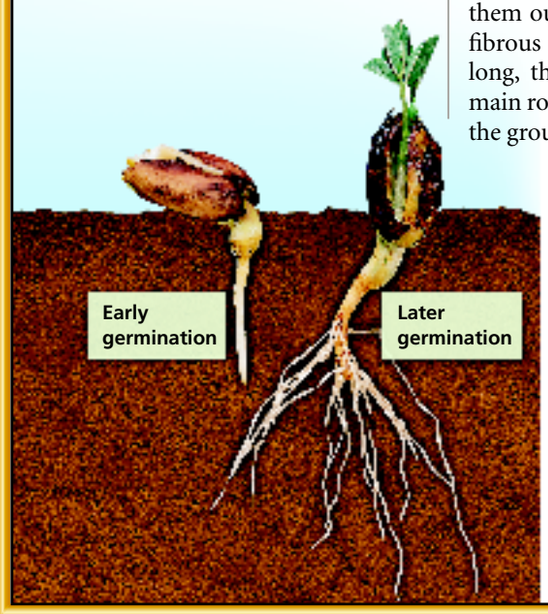


FIGURE 4
Germination
The embryo in this peanut seed uses its stored food to germinate. First, the embryo's roots grow downward. Then, its stem and leaves begin to grow upward.

The Structure of a Root In Figure 5, you can see the structure of a typical root. Notice that the tip of the root is rounded and is covered by a structure called the root cap. The **root cap** protects the root from injury from rocks as the root grows through the soil. Behind the root cap are the cells that divide to form new root cells.

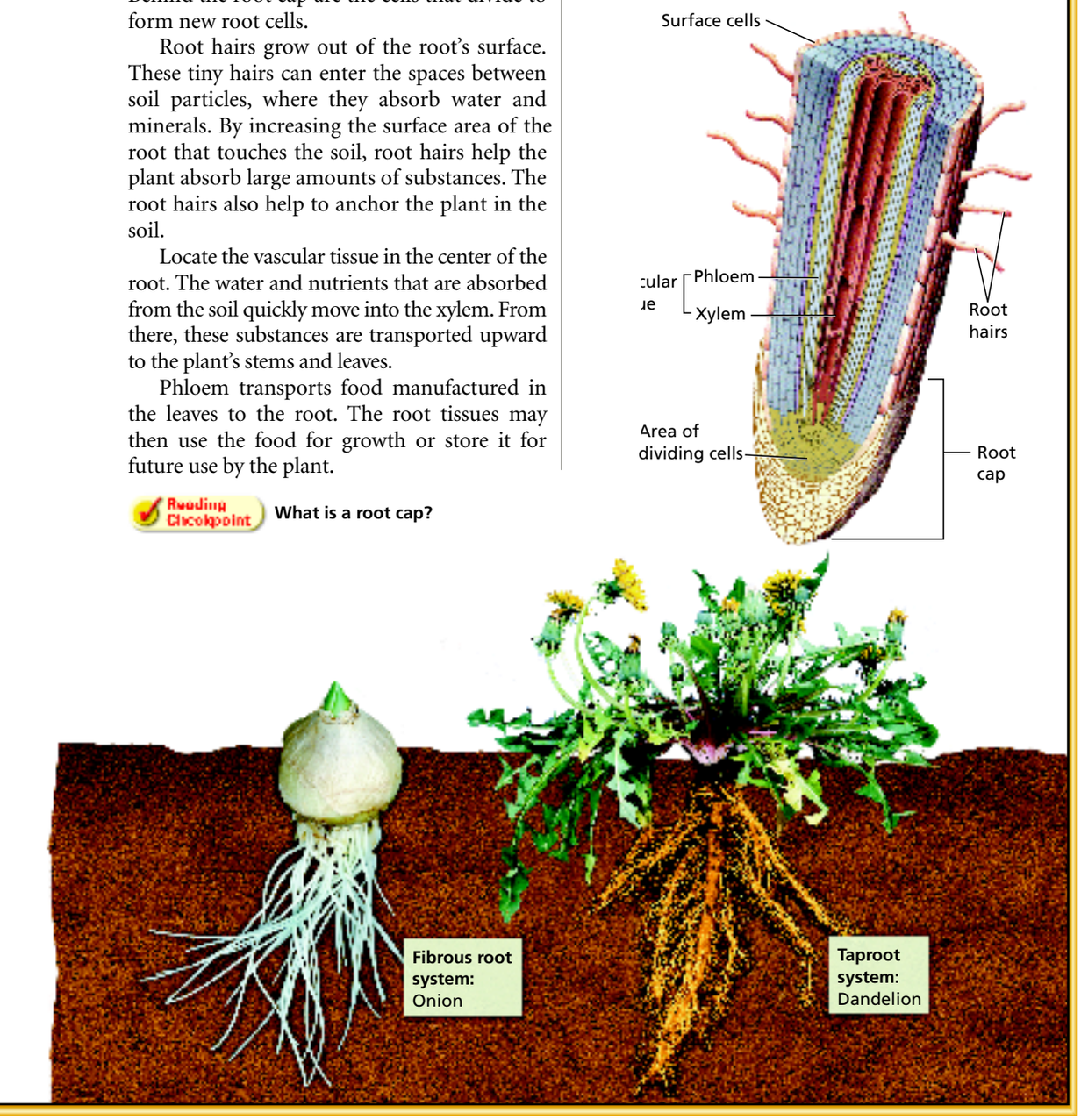
Root hairs grow out of the root's surface. These tiny hairs can enter the spaces between soil particles, where they absorb water and minerals. By increasing the surface area of the root that touches the soil, root hairs help the plant absorb large amounts of substances. The root hairs also help to anchor the plant in the soil.

Locate the vascular tissue in the center of the root. The water and nutrients that are absorbed from the soil quickly move into the xylem. From there, these substances are transported upward to the plant's stems and leaves.

Phloem transports food manufactured in the leaves to the root. The root tissues may then use the food for growth or store it for future use by the plant.

Reading Checkpoint **What is a root cap?**

FIGURE 5
Root Structure
Some plants have fibrous roots while others have taproots. A root's structure is adapted for absorbing water and minerals from the soil.
Relating Cause and Effect *How do root hairs help absorb water and minerals?*



Differentiated Instruction

Special Needs L1

Relating Key Terms to Visuals Students who have difficulty processing information may benefit from relating key terms and structures of plants to visuals. Pair students with more able students. Have them write the key terms in this section on one side of an index card and draw a picture of the term on the other side. Encourage students to make up cards for key concepts as well. Then have partners form small groups of four students and guess the key terms of concepts by looking only at the illustrations. **learning modality: visual**

Lab zone Teacher Demo L1

Observing Roots

Materials small potted plant with a fibrous root system, such as a geranium; newspapers

Time 10 minutes

Focus Review the two types of roots.

Teach Loosen the geranium from the container and hold it over newspapers to collect dirt. Gently tap the soil around the roots to make the root system visible. Have students sketch the root system for both plants, labeling the structures.

Apply Ask students to explain how the structure of roots is related to their function. *(They are long so they can stretch out into the spaces between soil particles to anchor the plant and absorb water and minerals.)*
learning modality: visual

Use Visuals: Figure 5 L2

Root Structure

Focus Encourage students to study the diagram of a root in Figure 5.

Teach Ask: **What tissue is made up of the phloem and xylem?** *(Vascular tissue)* **Where is the vascular tissue located?** *(In the center)*

Apply Ask: **Which part of the root would you expect to grow longer as the root grows?** *(The area of dividing cells; the root cap contains dead cells and cannot grow.)*
learning modality: visual

Monitor Progress L2

Writing Have students write a description of roots that includes their purposes, types, and structure.

Answers

Figure 5 They increase the amount of water and minerals aborbed by the plant.

Reading Checkpoint A seed must absorb water from the environment.

Reading Checkpoint A structure that covers and protects the tip of the root

Stems

Help Students Read

Active Comprehension Have students read the first paragraph of *Stems*. Then ask: **What would you like to know about stems?** *(Possible answers: Are the stems of trees and flowers similar? How are substances transported through stems?)* Write student responses on the board and have students read the remainder of the selection. After students are finished reading, ask them to respond to each question.

Teach Key Concepts L2

The Functions of Stems

Focus Remind students that nonvascular plants grow very close to the ground so that they can obtain the water they need. Indicate that stems are unique to vascular plants.

Teach Ask students to name the functions of stems. *(Stems carry water and nutrients from roots to leaves and food from leaves to roots. Stems support plants and hold leaves so that they are exposed to sunlight. Some stems also store food.)* Point out the structures in Figures 6 and 7. Ask: **How can you distinguish between the two types of stems? What are their names?** *(Woody stems contain wood and are hard and rigid; herbaceous stems are often soft and flexible and do not contain wood.)*

Apply Ask: **What will happen to a tree if a wound encircling the tree cuts through to the inner bark?** *(Because the inner bark is the phloem, the tree will be unable to transport food from leaves to other parts of the tree. It will die.)* **learning modality: verbal**

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- Transparencies A40, A41

Lab zone Skills Activity

Calculating

In this activity, you will calculate the speed at which water moves up a celery stalk.

1. Pour about 1 cm of water into a tall plastic container. Stir in several drops of red food coloring.
2. Place the freshly cut end of a celery stalk in the water. Lean the stalk against the container's side.
3. After 20 minutes, remove the celery. Use a metric ruler to measure the height of the water in the stalk.
4. Use the measurement and the following formula to calculate how fast the water moved up the stalk.

$$\text{Speed} = \frac{\text{Height}}{\text{Time}}$$

Based on your calculation, predict how far the water would move in 2 hours. Then test your prediction.

Stems

The stem of a plant has two main functions. **The stem carries substances between the plant's roots and leaves. The stem also provides support for the plant and holds up the leaves so they are exposed to the sun.** In addition, some stems, such as those of asparagus, store food.

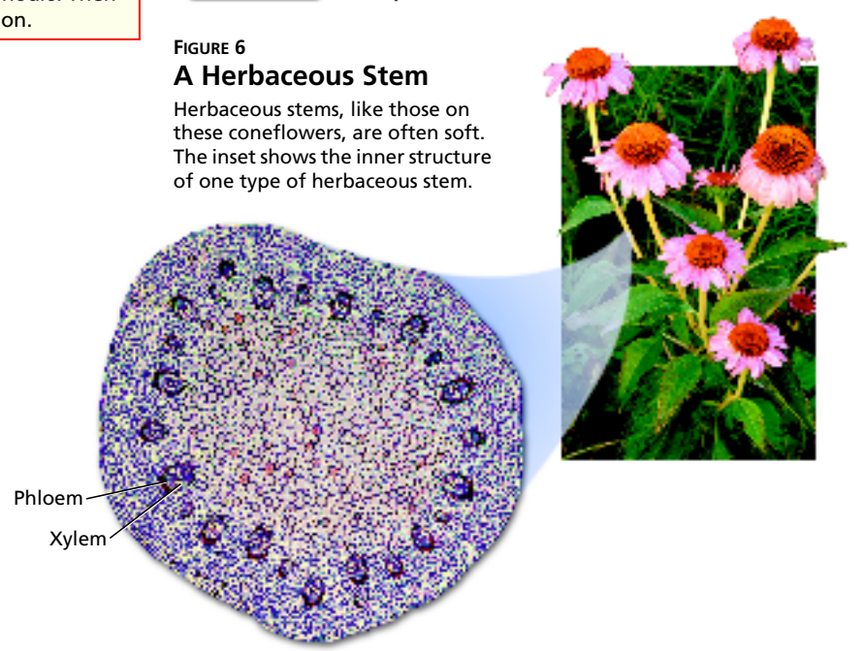
The Structure of a Stem Stems can be either herbaceous (hur BAY shus) or woody. Herbaceous stems contain no wood and are often soft. Coneflowers and pepper plants have herbaceous stems. In contrast, woody stems are hard and rigid. Maple trees and roses have woody stems.

Both herbaceous and woody stems consist of phloem and xylem tissue as well as many other supporting cells. Figure 6 shows the inner structure of one type of herbaceous stem.

As you can see in Figure 7, a woody stem contains several layers of tissue. The outermost layer is bark. Bark includes an outer protective layer and an inner layer of living phloem, which transports food through the stem. Next is a layer of cells called the **cambium** (KAM bee um), which divide to produce new phloem and xylem. It is xylem that makes up most of what you call "wood." Sapwood is active xylem that transports water and minerals through the stem. The older, darker, heartwood is inactive but provides support.

Reading Checkpoint **What function does the bark of a woody stem perform?**

FIGURE 6
A Herbaceous Stem
Herbaceous stems, like those on these coneflowers, are often soft. The inset shows the inner structure of one type of herbaceous stem.



Lab zone Skills Activity

Skills Focus calculating L2

Materials calculator, celery stalk, clock or stopwatch, dropper, food coloring, lab apron, plastic container (tall and narrow), spoon, water

Time 35 minutes (20 wait time); 2 hours wait time to test prediction

Tips Make sure students wear lab aprons. Choose stalks 15–30 cm long. Before the activity, cut the end of each stalk, and peel a thin layer off the back of each.

Expected Outcome The water moves about 1.5 mm/min (30 mm ÷ 20 min). After 2 hours, it should rise 180 mm (120 min × 1.5 mm/min).

Extend Have students repeat the activity with another plant, such as a green onion or a leek. **learning modality: logical/mathematical**

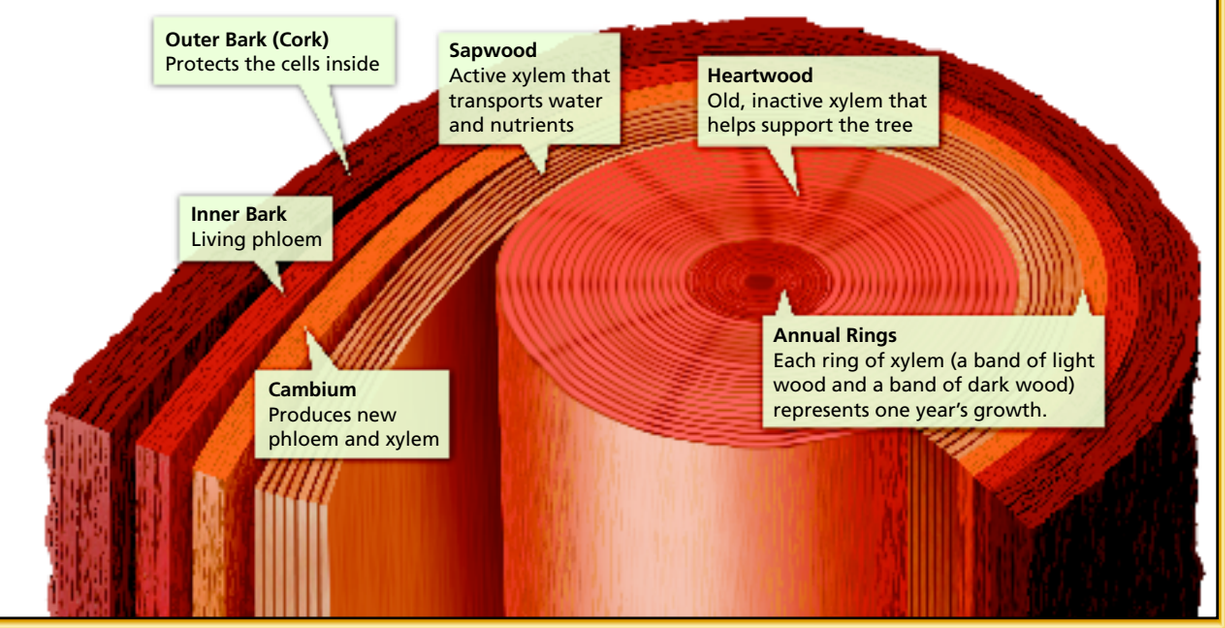
Annual Rings Have you ever looked at a tree stump and seen a pattern of circles that looks something like a target? These circles are called annual rings because they represent a tree's yearly growth. Annual rings are made of xylem. Xylem cells that form in the spring are large and have thin walls because they grow rapidly. They produce a wide, light brown ring. Xylem cells that form in the summer grow slowly and, therefore, are small and have thick walls. They produce a thin, dark ring. One pair of light and dark rings represents one year's growth. You can estimate a tree's age by counting its annual rings.

The width of a tree's annual rings can provide important clues about past weather conditions, such as rainfall. In rainy years, more xylem is produced, so the tree's annual rings are wide. In dry years, rings are narrow. By examining annual rings from some trees in the southwestern United States, scientists were able to infer that severe droughts occurred in the years 840, 1067, 1379, and 1632.

FIGURE 7

A Woody Stem

Trees like these maples have woody stems. A typical woody stem is made up of many layers. The layers of xylem form annual rings that can reveal the age of the tree and the growing conditions it has experienced.
Interpreting Diagrams *Where is the cambium located?*



Address Misconceptions L1

Grow Up or Grow Wide?

Focus Some students think that trees simply "grow up" the same way that grasses grow.

Teach Have students study the layers of bark shown in Figure 7. Point out that the heartwood is old xylem and is at the center of the trunk. Ask: **Where would you expect to find new growth?** *(Near the outer portion of the trunk)* Indicate that trees grow by adding layers to the outside of the stem. The outer rings in a tree trunk are newer than the inner rings.

Apply Tell students that to collect sap from maple trees, farmers cut a "V" shape into the bark of the tree a few feet above ground. Ask: **If a farmer comes back to the same tree in two years, where will the "V" cut be? Explain.** *(At about the same height; as the tree grows wider, it grows upward above the cut.)* **learning modality: verbal**

Lab zone Build Inquiry L2

Observing Tree Rings

Materials cross-sectional slice of a tree trunk (you can obtain by slicing through a log for firewood), hand lens

Time 15 minutes

Teach Have students examine the rings in the trunk and find three pairs of dark and light rings of different widths.

Apply Ask students to infer which pair represents the year of heaviest rainfall and which pair represents the year of lightest rainfall. *(The ring pair with the greatest width grew in years of heaviest rainfall. The ring pair with the smallest width grew in the year of the lightest rainfall.)* **learning modality: visual**

Differentiated Instruction

Special Needs L1

Making Models of Tree Stems Have student pairs roll up several sheets of newspaper paper and place them inside the core of an empty role of paper toweling or bathroom tissue. Tell students that the core and the paper in it represent the center of a woody stem. Next, have students label five additional sheets of paper *old xylem, active xylem, cambium, active phloem,* and *outer bark*. Direct students to wrap these sheets around their model in the correct order. Finally, have partners take turns unwrapping the model, naming and explaining the function of each layer. **learning modality: kinesthetic**

Monitor Progress L2

Drawing Have students sketch and label the layers in a woody stem. Students can save their drawings in their portfolios.

Answers

Figure 7 It is inside the inner bark.

Reading Checkpoint It protects the inner cells of woody plants.

Go Online PHSchool.com
For: More on leaves
Visit: PHSchool.com
Web Code: ced-1051
Students can review leaves in an online interactivity.

Leaves

Teach Key Concepts L2

The Functions of Leaves

Focus Remind students that plants are autotrophs—they make their own food.

Teach Ask: **How do leaves provide food for a plant?** *(They capture energy from sunlight and use it to carry out photosynthesis.)* Have students examine Figure 8 as you ask questions such as **Where are the stomata mostly found?** *(On a leaf's underside)* **What do they do?** *(They open to let in carbon dioxide, and allow water vapor and oxygen to leave. They close to conserve water.)* **What happens to the sugars made in the leaf during photosynthesis?** *(They enter the phloem and travel to other parts of the plant.)*

Apply Ask: **If the temperature is not very hot, when would stomata generally be open and closed?** *(Open during the daytime when sunlight is available and photosynthesis is active; closed at night when open stomata would only lead to water loss)* **learning modality: verbal**

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Use Visuals: Figure 8 L2

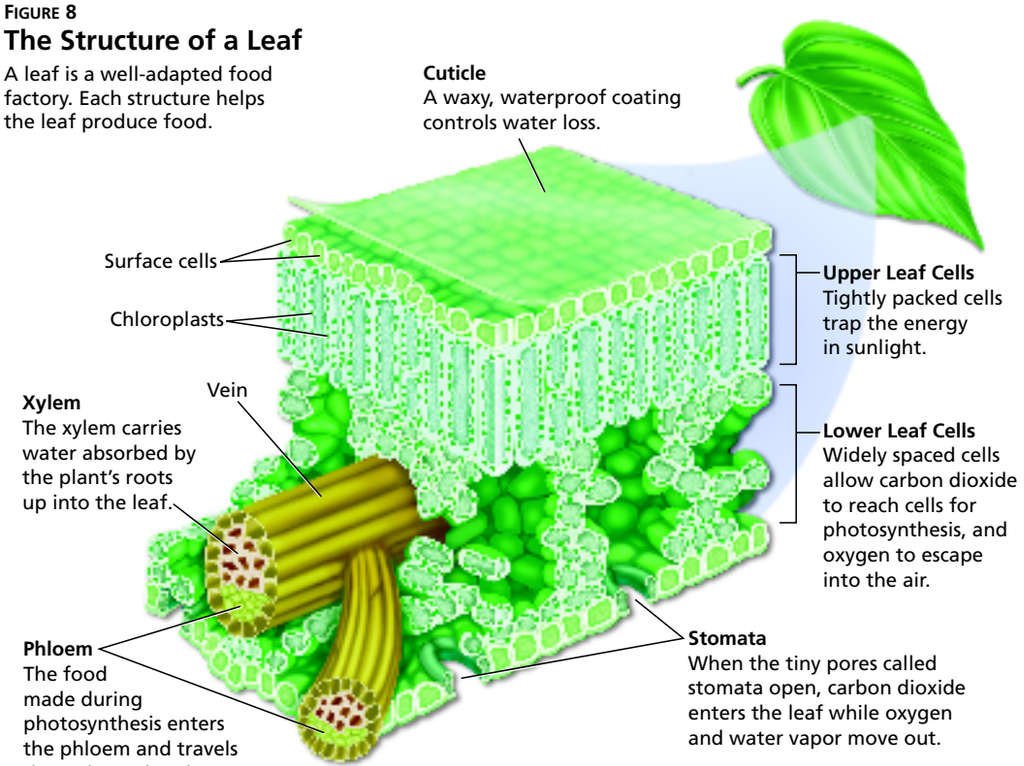
The Structure of a Leaf

Focus Ask student volunteers to read each caption in the figure.

Teach Ask: **Where is the leaf cuticle and what does it do?** *(It covers the leaf's surface and prevents water loss.)* **Where are the chloroplasts?** *(In the upper and lower leaf cells)* **What structure contains the xylem and phloem?** *(Vein)*

Apply Ask: **What is the benefit of upper leaf cells that are densely packed, rather than loosely packed?** *(Densely packed cells can collect more energy for photosynthesis.)* **learning modality: visual**

FIGURE 8
The Structure of a Leaf
A leaf is a well-adapted food factory. Each structure helps the leaf produce food.



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Leaves

Leaves vary greatly in size and shape. Pine trees, for example, have needle-shaped leaves. Birch trees have small rounded leaves with jagged edges. Regardless of their shape, leaves play an important role in a plant. **Leaves capture the sun's energy and carry out the food-making process of photosynthesis.**

The Structure of a Leaf If you were to cut through a leaf and look at the edge under a microscope, you would see the structures in Figure 8. The leaf's top and bottom surface layers protect the cells inside. Between the layers of cells are veins that contain xylem and phloem.

The surface layers of the leaf have small openings, or pores, called **stomata** (STOH muh tuh) (singular *stoma*). The Greek word *stoma* means "mouth"—and stomata do look like tiny mouths. The stomata open and close to control when gases enter and leave the leaf. When the stomata are open, carbon dioxide enters the leaf, and oxygen and water vapor exit.

The Leaf and Photosynthesis The structure of a leaf is ideal for carrying out photosynthesis. The cells that contain the most chloroplasts are located near the leaf's upper surface, where they get the most light. The chlorophyll in the chloroplasts traps the sun's energy.

Carbon dioxide enters the leaf through open stomata. Water, which is absorbed by the plant's roots, travels up the stem to the leaf through the xylem. During photosynthesis, sugar and oxygen are produced from the carbon dioxide and water. Oxygen passes out of the leaf through the open stomata. The sugar enters the phloem and then travels throughout the plant.

Controlling Water Loss Because such a large area of a leaf is exposed to the air, water can quickly evaporate, or be lost, from a leaf into the air. The process by which water evaporates from a plant's leaves is called **transpiration.** A plant can lose a lot of water through transpiration. A corn plant, for example, can lose almost 4 liters of water on a hot summer day. Without a way to slow down the process of transpiration, a plant would shrivel up and die.

Fortunately, plants have ways to slow down transpiration. One way that plants retain water is by closing the stomata. The stomata often close when leaves start to dry out.

Reading Checkpoint **How does water get into a leaf?**

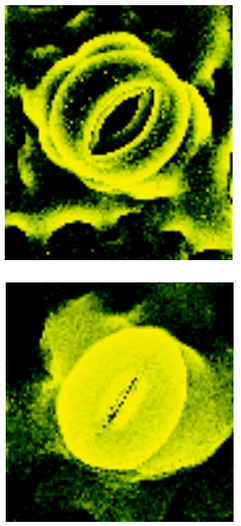

FIGURE 9
Stomata
Stomata open (top) and close (bottom) to control when gases enter and exit the leaf.
Relating Cause and Effect *What gases enter and exit when the stomata open?*

Section 1 Assessment

Target Reading Skill **Outlining** Use the information in your outline about seed plants to help you answer the questions below.

Reviewing Key Concepts

1. a. **Reviewing** What two characteristics do all seed plants share?
   b. **Relating Cause and Effect** What characteristics enable seed plants to live in a wide variety of environments? Explain.
2. a. **Listing** Name the three main parts of a seed.
   b. **Sequencing** List the steps in the sequence in which they must occur for a seed to grow into a new plant.
   c. **Applying Concepts** If a cherry seed were to take root right below its parent tree, what three challenges might the cherry seedling face?
3. a. **Identifying** What are the main functions of a plant's roots, stems, and leaves?
   b. **Comparing and Contrasting** Compare the path on which water moves through a plant to the path on which sugar moves through a plant.
   c. **Applying Concepts** How are the structures of a tree's roots and leaves well-suited for their roles in supplying the tree with water and sugar?

Writing in Science

Product Label Write a "packaging label" for a seed. Include a name and description for each part of the seed. Be sure to describe the role of each part in producing a new plant.

Monitor Progress L2

Answers

Figure 9 Carbon dioxide enters the leaf, and water vapor and oxygen exit.

Reading Checkpoint It is absorbed by the roots and travels up the stem to the leaf through the xylem.

Assess

Reviewing Key Concepts

1. a. They have vascular tissue and they use pollen and seeds to reproduce. **b.** They have structures to bring water and nutrients to all parts of the plant, and they do not need water for fertilization to occur.
2. a. Embryo, stored food, seed coat
b. Dispersal, absorb water, germination, embryo begins to grow, plant leaves emerge
c. It would compete with the parent tree for light, water, and minerals.
3. a. Roots—anchor plant, absorb water and nutrients from soil, some store food; stems—carry substances between roots and leaves, some store food; leaves—capture sun's energy and carry out photosynthesis
b. Water moves from roots to leaves through the xylem; sugar moves from leaves to stems, roots, and other parts, through phloem.
c. Tree roots have root hairs that help absorb water from the soil. Roots have xylem to carry water to leaves. Sugar made by the chloroplasts in the leaves moves to phloem and then travels to all parts of the plant.

Reteach L1

Use the section figures to summarize the functions of roots, stems, and leaves.

Performance Assessment L2

Oral Presentation Have groups of students make posters showing the functions of leaves, stems, or roots, then present their posters to the class.

All in One Teaching Resources

- Section Summary: *The Characteristics of Seed Plants*
- Review and Reinforce: *The Characteristics of Seed Plants*
- Enrich: *The Characteristics of Seed Plants*

Lab zone Chapter Project

Keep Students on Track By now seeds should have germinated and students begun making their observations. If some seeds have not germinated, allow students to start over or to observe seeds that have germinated. Make certain students are preparing detailed diagrams, drawings, or photographs of their observations.

Writing in Science

Writing Mode Description

Scoring Rubric

4 Includes the name, function, and description for each part of a seed; uses vivid descriptions that resemble a real label and engage the reader
3 Includes all criteria, but descriptions are uninteresting
2 Includes brief but accurate descriptions
1 Includes incomplete or inaccurate descriptions